

**APHIS BOYDSTONI, N. SP., AND APHIS CEANOETHI CLARKE (HEMIPTERA:
APHIDIDAE: APHIDINAE) ON CEANOETHUS VELUTINUS DOUGLAS,
INCLUDING ASSOCIATED PARASITOIDS**

K. S. PIKE, R. G. FOOTTIT, P. STARÝ, D. W. ALLISON, G. GRAF, AND H. E. L. MAW

(KSP) Entomologist and (DWA, GG) Research Technicians, Washington State University, Irrigated Agriculture Research and Extension Center, 24106 N Bunn Road, Prosser, WA 99350, U.S.A. (e-mail: kpike@wsu.edu); (RGF) Entomologist and (HELM) Research Technician, Agriculture and Agri-Food Canada, K. W. Neatby Building, Central Experimental Farm, 960 Carling Avenue, Ottawa, Canada K1A 0C6; (PS) Entomologist, Institute of Entomology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic

Abstract.—*Aphis boydstoni* Pike, n. sp. (Hemiptera: Aphididae: Aphidinae), is described and illustrated. The aphid, which was found in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon, is a monoecious holocyclic feeder of *Ceanothus velutinus* Douglas (Rhamnaceae). Its morphology and associated parasitoids are compared with those of *Aphis ceanothi* Clarke, the only other aphid known to feed on *Ceanothus*.

Key Words: aphid, *Aphis*, *Ceanothus*, new species, description, parasitoids, *Aphidius*, *Binodoxys*, *Diaeretiella*, *Lysiphlebus*, *Praon*, *Alloxysta*, *Lytoxysta*, *Phaenoglyphis*, *Asaphes*, *Pachyneuron*, *Dendrocerus*

Research on parasitoids of *Aphis ceanothi* Clarke in northwestern North America (Pike et al. 2000) led to the discovery of a new species of aphid on *Ceanothus velutinus* Douglas (Rhamnaceae) in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon. Descriptions, illustrations, parasitoid associations, and diagnoses are provided for this aphid and for *Aphis ceanothi* Clarke, the only other aphid that feeds on *Ceanothus*.

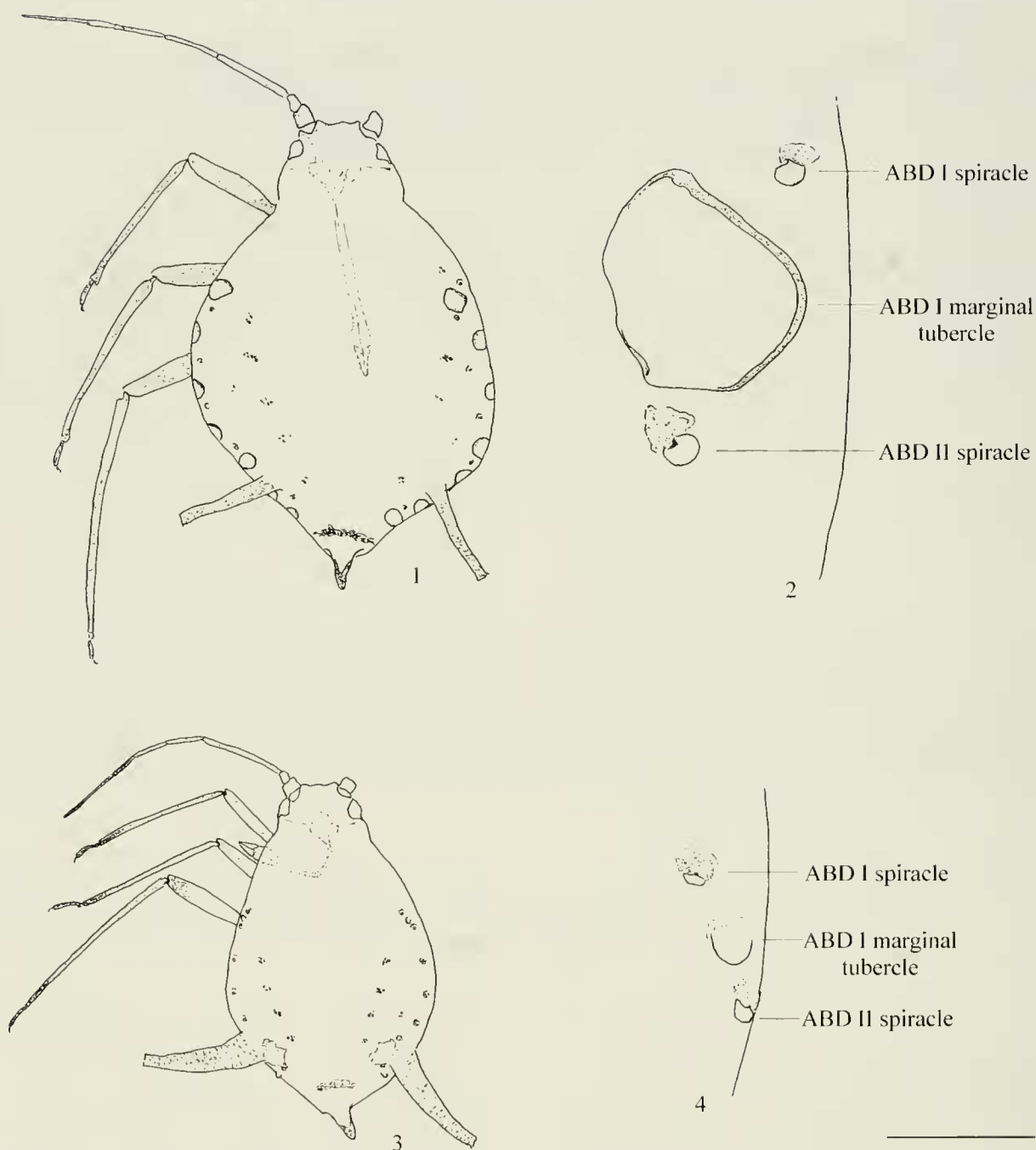
MATERIAL AND METHODS

The new species of aphid was collected from *Ceanothus velutinus* at numerous sites along the eastern slopes of the Cascade Mountains of Washington and Canada, and at two sites in the Blue Mountains of

Oregon at elevations within the range of 600 to 1200 m. The collected aphids were preserved in ethanol, and subsequently cleared and mounted on microscope slides in Canada balsam. Some specimens were processed using techniques published by Hille Ris Lambers (1950) with modifications by D. Voegtlin of the Illinois Natural History Survey (See Pike et al. 1991), and some were processed using techniques by Foottit and Maw (see website, <http://www.zoology.ubc.ca/~mawe/bcaphid>).

The aphid description is attributed to the first author. Illustrations were hand drawn from images taken with a Nikon Coolpix 990TM digital camera.

All of the aphid-parasitoids associated with the *Ceanothus*-feeding aphids were reared from field collected material held in



Figs. 1-4. 1-2, *Aphis boydstoni*. 1, Apterous vivipara. 2, Abdominal marginal tubercle I and spiracles I-II. 3-4, *Aphis ceanothi*. 3, Apterous vivipara. 4, Abdominal marginal tubercle I and spiracles I-II. Bar scale: Figs. 1, 3 = 0.8 mm; Figs. 2, 4 = 0.1 mm.

semi-transparent plastic containers on clipped foliage at ambient laboratory temperatures ranging from 17 to 23°C for 30 days.

***Aphis boydstoni* Pike, new species**

(Figs. 1-2, 5-12)

Etymology.—The species is named in honor of Leslie Boydston, former Washington State University Research Technologist, who contributed significantly for many years to the research on aphids in north-western USA.

Description.—*Apterous vivipara* (Figs. 1-2, 5-10): Coloration in life, reddish brown to blackish. Prepared specimens: Adult: body length 1.59 to 2.86 mm. Body relatively pale, appendages pigmented. Abdominal dorsum membranous, pale, except for some sclerotic pigmentation on posterior terga. Longest setae on head and antennal segment III usually longer than basal width of antennal III. Frontal tubercles (= antennal tubercles) weakly developed, diverging, and relatively smooth. Median tubercle weakly developed, height $\leq$ frontal

tubercles, surface sculpturing similar to frontal tubercles. Antenna 0.6–0.9 $\times$ body length; 6-segmented without secondary rhinaria; primary rhinaria with conspicuous ciliate margins. Ultimate rostral segment tapering, rounded distad of preapical primary setae, usually with 2 secondary setae. Claws simple; empodial setae acuminate, not reaching claw apices. Abdominal segments I–VII with wide, nearly flat marginal tubercles (marginal tubercle I diameter = 0.08–0.14 mm); spiracles subcircular without opercula. Siphunculus imbricated throughout, tapering (narrower at apex than base), and weakly flanged. Cauda tapering with broadly rounded apex. For a full range of morphological measurements and comparisons, see Table 1.

Alate vivipara: Morphological features generally similar to apterous vivipara (see Table 1). Antenna (Fig. 11) with secondary rhinaria on III, sometimes IV; abdominal dorsum largely membranous, but with post-siphuncular sclerites, slight transverse pigmentation on posterior terga, and pigmented marginals.

Ovipara: Morphological features generally similar to apterous vivipara (see Table 1). Lateral ocelli usually absent, but sometimes a trace indicated; hind tibia with 3–22 pseudorhinaria (Fig. 12).

Diagnosis.—Wide, nearly flat marginal tubercles on abdominal segments I–VII [largest tubercles on segments I (0.07–0.15 mm diameter) and VII (0.04–0.12 mm)], and frequent presence of a few siphuncular setae (diagnosis applies to all known adult forms of *A. boydstoni*). *Aphis ceanothi*, the other aphid known to feed on *Ceanothus* (see Clarke 1903, Gillette and Palmer 1932, Palmer 1952, Smith and Parron 1978, Maw et al. 2000, Pike et al. 2003), in comparison with *A. boydstoni*, has smaller tubercles on abdominal segments I and VII, lacks marginal tubercles on abdominal segments II–VI, and manifests fewer caudal setae. Table 2 summarizes the morphological features of *Aphis ceanothi* for use in characterizing similarities and differences between the two

Ceanothus-inhabiting species. Regarding other *Aphis* spp., none in North America has the wide, nearly flat marginal tubercles like *A. boydstoni*.

A European aphid with large marginal tubercles, *Aphis mammulata* Gimmingham and Hille Ris Lambers (1949), which feeds on *Rhamnus*, in the same plant family as *Ceanothus*, is easily distinguishable from *A. boydstoni* by its abdominal marginals that are strongly conical as opposed to flat or nearly flat.

Material.—Holotype: apterous viviparous ♀—USA, Washington, Klickitat Co., east of Glenwood near Klickitat River, 6-VI-2000, on *Ceanothus velutinus* Douglas (WSU Code A0K055-1), collector K. S. Pike. Paratypes (all from *Ceanothus velutinus*) [abbreviations: ap, apterous viviparae; al, alate viviparae; ov, oviparae]: Washington, Yakima Co.—type locality, 7-VI-95 (5 ap, 3 al, A0K055); near type locality, 19-IV-96 (1 ap, 96G580); Yakama Nation along Klickitat River, 7-VI-1995 (3 ap, 95G132), 11-VII-95 (2 ap, 1 al, 95K061), 19-IX-95 (3 ap, 7 ov, 95G627), Klickitat Canyon, 23-VI-1995, (4 ap, 4 al, 95G230); Goose Egg Mountain, 23-VII-2000 (3ap, 1 al, A0G564); Rimrock Lake, 25-VII-2003 (18 ap, A3G311); Chelan Co., 16 km north of Blewett Pass, 8-VIII-2000 (1 ap, A0G600); Oregon—Grant Co., Hwy 7, 3.6 km east of Austin Junction, 27-VII-2000 (5 ap, A0G581), Baker Co., Hwy 7, 4.2 km west of Sumpter (3 ap, A0G583); Canada, British Columbia, northwest of Peachland along Silver Lake Road, 14-VIII-1998 (8 ap, 98EM0524). Holotype deposited in National Museum of Natural History, Smithsonian Institution, Beltsville, MD (USNM). Paratypes—2 ap, 2 al, and 1 ov, deposited in USNM; 9 ap, 2 al, and 1 ov deposited in Canadian National Collection, Ottawa. Other paratypes deposited in the Washington State University aphid collection, Prosser.

Biology and distribution.—*Aphis boydstoni* is holocyclic monoecious on *Ceanothus velutinus* Douglas, a shrub known as mountain balm or sticky laurel. It has been

Table 1. Morphological measurements (mm) and comparisons for adult morphs of *Aphis boydstoni*.

	Apterous Vivipara n = 32		Alate vivipara n = 7		Ovipara n = 5	
	Mean	(Range)	Mean	(Range)	Mean	(Range)
Body (length)	2.15	(1.59-2.86)	2.37	(2.09-2.71)	1.88	(1.62-2.22)
Head						
Head (width)	0.51	(0.42-0.58)	0.49	(0.47-0.54)	0.46	(0.41-0.53)
Antenna						
1-V1 (length)	1.63	(1.33-1.92)	1.93	(1.84-2.03)	1.43	(1.34-1.59)
III (length)	0.38	(0.25-0.52)	0.49	(0.46-0.52)	0.29	(0.25-0.35)
III (width at base)	0.034	(0.027-0.041)	0.035	(0.031-0.037)	0.028	(0.024-0.032)
IV (length)	0.27	(0.20-0.36)	0.34	(0.30-0.37)	0.23	(0.21-0.28)
V (length)	0.27	(0.23-0.33)	0.33	(0.32-0.34)	0.23	(0.21-0.26)
Processus terminalis (length)	0.37	(0.33-0.45)	0.42	(0.38-0.47)	0.34	(0.33-0.35)
Base of antennal VI (length)	0.16	(0.14-0.18)	0.17	(0.16-0.17)	0.15	(0.15-0.16)
Base of antennal VI (width at base)	0.024	(0.018-0.030)	0.022	(0.021-0.024)	0.019	(0.017-0.022)
Antenna III secondary rhinaria	0	—	27.1	(22-31)	0	—
Antenna IV secondary rhinaria	0	—	0.6	(0-2)	0	—
Antenna V secondary rhinaria	0	—	0	—	0	—
Longest seta on antennal III (length)	0.040	(0.032-0.049)	0.038	(0.033-0.044)	0.036	(0.030-0.042)
Longest seta on vertex (length)	0.041	(0.032-0.046)	0.040	(0.035-0.043)	0.037	(0.034-0.045)
Ultimate rostral segment (length)	0.16	(0.15-0.18)	0.16	(0.16-0.17)	0.16	(0.15-0.17)
Ultimate rostral segment (width at base)	0.077	(0.060-0.099)	0.075	(0.068-0.078)	0.066	(0.064-0.071)
Ultimate rostral segment assessor setae	2.2	(1-5)	2.3	(2-4)	2.0	(2-2)
Thorax						
Hind tibia (length)	1.16	(0.94-1.48)	1.44	(1.33-1.57)	0.99	(0.86-1.21)
Longest seta near apex of tibia (length)	0.040	(0.033-0.047)	0.039	(0.034-0.047)	0.036	(0.031-0.039)
Tibial rhinaria	0	—	0	—	13.7	(3-22)
Tarsal I chaetotaxy	3-3-3		3-3-3		3-3-3	
Hind tarsus II (length)	0.14	(0.12-0.17)	0.14	(0.13-0.16)	0.13	(0.12-0.14)
Hind tarsus II (width at mid-segment)	0.027	(0.023-0.032)	0.027	(0.024-0.031)	0.026	(0.024-0.028)
Hind tarsal II accessory setae	4.5	(3-5)	4.6	(4-6)	3.4	(2-4)
Trochanter-femoral suture (length)	0.060	(0.047-0.076)	0.057	(0.055-0.060)	0.051	(0.045-0.059)
Longest seta on trochanter (length)	0.044	(0.038-0.054)	0.039	(0.032-0.045)	0.046	(0.042-0.052)

Table 1. Continued

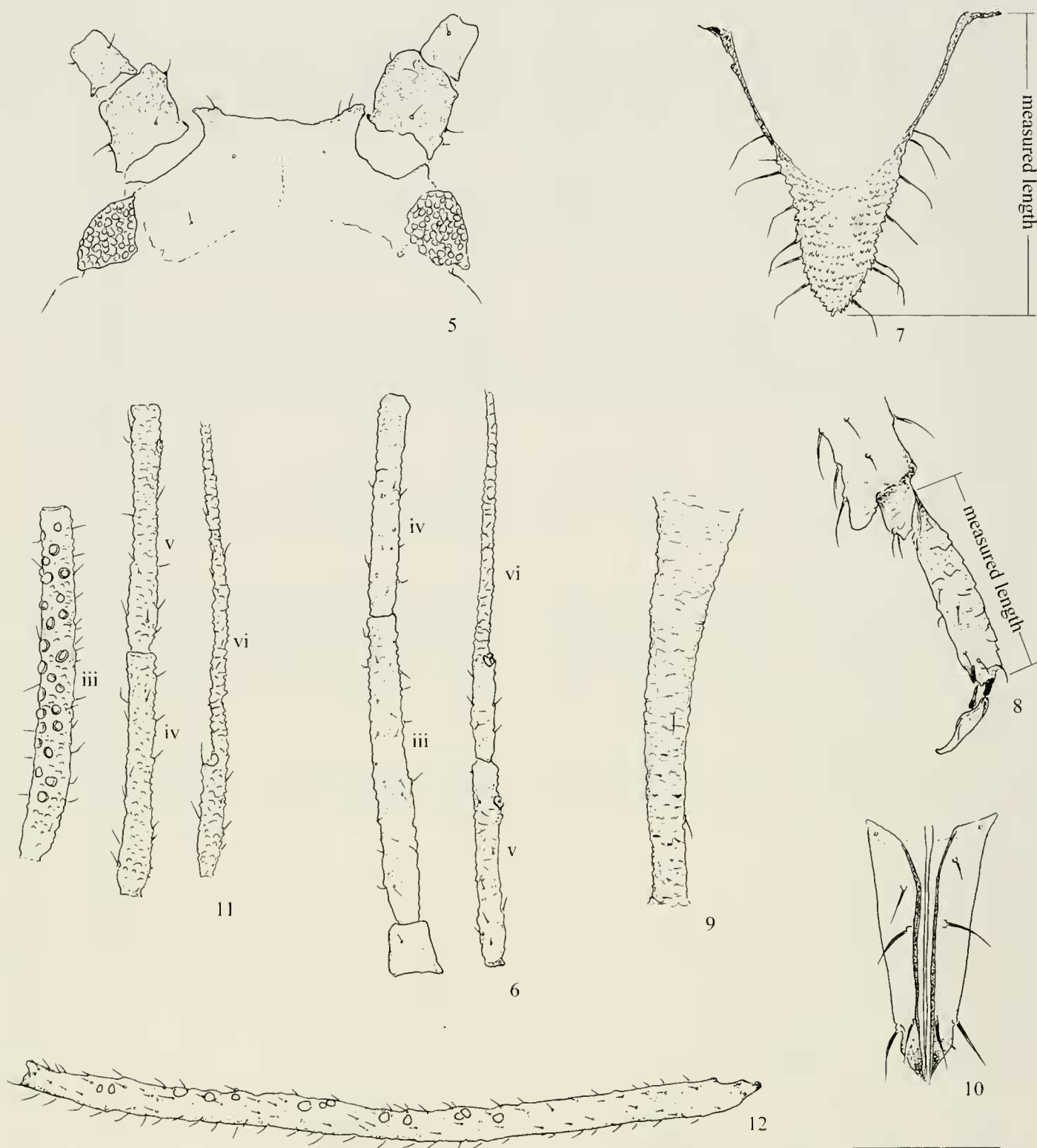
	Apterous Vivipara n = 32		Alate vivipara n = 7		Ovipara n = 5	
	Mean	(Range)	Mean	(Range)	Mean	(Range)
Abdomen						
Siphunculus (length)	0.41	(0.25–0.57)	0.43	(0.40–0.49)	0.27	(0.21–0.43)
Siphunculus (width at base)	0.10	(0.06–0.15)	0.09	(0.07–0.11)	0.058	(0.050–0.083)
Siphuncular setae	1.4	(0–7)	0.3	(0.0–1.5)	1.3	(0.0–2.5)
Cauda (length)	0.19	(0.16–0.24)	0.21	(0.19–0.23)	0.19	(0.18–0.19)
Cauda (width at base)	0.15	(0.11–0.20)	0.15	(0.13–0.17)	0.12	(0.12–0.12)
Caudal setae	17.5	(13–22)	17.0	(11–20)	18.2	(15–20)
Marginal tubercle I (diameter)	0.10	(0.08–0.14)	0.13	(0.08–0.15)	0.09	(0.07–0.11)
Marginal tubercle VII (diameter)	0.08	(0.04–0.11)	0.09	(0.08–0.12)	0.05	(0.04–0.07)
Comparisons						
Head/antennal III (width/length)	1.4	(1.1–2.9)	1.0	(0.9–1.1)	1.5	(1.5–1.6)
Antenna/body (length)	0.77	(0.61–0.94)	0.84	(0.72–0.97)	0.73	(0.70–0.77)
Antenna III (length/width at base)	11.1	(8.7–14.6)	14.1	(12.7–15.0)	10.4	(9.0–11.5)
Length of longest seta on antennal III/basal width of antennal III	1.19	(0.98–1.46)	1.09	(0.91–1.21)	1.29	(1.04–1.57)
Antenna VI base (length/width at base)	6.8	(5.3–8.6)	7.4	(6.8–8.3)	8.2	(7.2–9.1)
Processus terminalis/antennal VI base (length)	2.4	(2.0–2.8)	2.5	(2.2–2.9)	2.2	(2.2–2.2)
Length of longest seta on vertex/basal width of antennal III	1.21	(0.90–1.50)	1.14	(0.95–1.34)	1.34	(1.14–1.43)
Ultimate rostral segment (length/width at base)	2.1	(1.6–2.5)	2.2	(2.1–2.4)	2.4	(2.3–2.4)
Ultimate rostral segment/hind tarsus II (length)	1.2	(1.0–1.3)	1.1	(1.0–1.2)	1.2	(1.2–1.3)
Hind tarsus II (length/width at median)	5.3	(4.3–6.2)	5.4	(4.4–6.2)	5.0	(4.7–5.4)
Siphunculus (length/width at base)	4.1	(3.0–5.1)	4.8	(3.7–5.7)	4.7	(4.1–5.1)
Siphunculus/body (length)	0.19	(0.13–0.23)	0.18	(0.15–0.24)	0.15	(0.12–0.19)
Siphunculus/cauda (length)	2.1	(1.3–2.7)	2.1	(1.9–2.3)	1.3	(1.2–1.4)
Çauda (length/width at base)	1.3	(1.0–1.7)	1.4	(1.1–1.6)	1.6	(1.5–1.6)
Cauda/body (length)	0.09	(0.06–0.12)	0.09	(0.07–0.11)	0.11	(0.10–0.11)

Table 2. Morphological measurements (mm) and comparisons for adult morphs of *Aphis ceanothi*.

	Apterous Vivipara n = 79		Alate Vivipara n = 11		Apterous Male n = 3	
	Mean	(Range)	Mean	(Range)	Mean	(Range)
Body (length)	1.70	(1.19-2.28)	1.90	(1.60-2.39)	1.37	(1.18-1.54)
Head						
Head (width)	0.41	(0.34-0.51)	0.40	(0.34-0.45)	0.39	(0.36-0.42)
Antenna						
I-VI (length)	1.21	(0.95-1.53)	1.38	(1.13-1.70)	1.19	(1.05-1.27)
III (length)	0.31	(0.22-0.44)	0.37	(0.29-0.48)	0.32	(0.27-0.36)
III (width at base)	0.026	(0.021-0.039)	0.026	(0.023-0.030)	0.024	(0.021-0.026)
IV (length)	0.20	(0.13-0.27)	0.22	(0.16-0.28)	0.21	(0.17-0.24)
V (length)	0.19	(0.15-0.24)	0.21	(0.17-0.27)	0.19	(0.17-0.21)
Processus terminalis (length)	0.26	(0.21-0.32)	0.28	(0.22-0.32)	0.23	(0.22-0.25)
Base of antennal VI (length)	0.13	(0.11-0.18)	0.14	(0.13-0.18)	0.12	(0.11-0.12)
Base of antennal VI (width at base)	0.017	(0.014-0.022)	0.015	(0.013-0.018)	0.013	(0.013-0.014)
Antenna III secondary rhinaria	0	—	22.7	(16-36)	6.0	(3-9)
Antenna IV secondary rhinaria	0	—	0.8	(0-5)	8.5	(7-9)
Antenna V secondary rhinaria	0	—	0.1	(0-1)	7.7	(7-8)
Longest seta on antennal III (length)	0.035	(0.020-0.043)	0.034	(0.030-0.038)	0.025	(0.023-0.027)
Longest seta on vertex (length)	0.039	(0.031-0.049)	0.041	(0.033-0.048)	—	—
Ultimate rostral segment (length)	0.12	(0.11-0.13)	0.12	(0.11-0.13)	0.11	(0.10-0.11)
Ultimate rostral segment (width at base)	0.058	(0.043-0.076)	0.052	(0.045-0.060)	0.050	(0.048-0.052)
Ultimate rostral segment assessor setae	2.0	(2-3)	2.1	(2-3)	2.0	(2-2)
Thorax						
Hind tibia (length)	0.81	(0.58-1.06)	0.94	(0.75-1.20)	0.68	(0.56-0.76)
Longest seta near apex of tibia (length)	0.039	(0.031-0.049)	0.036	(0.030-0.044)	0.036	(0.033-0.042)
Tibial rhinaria	0	—	0	—	0	—
Tarsal I chaetotaxy	3-3-3		3-3-3		3-3-3	
Hind tarsus II (length)	0.13	(0.10-0.15)	0.13	(0.11-0.14)	0.11	(0.10-0.12)
Hind tarsus II (width at mid-segment)	0.022	(0.018-0.027)	0.020	(0.018-0.024)	0.024	(0.017-0.029)
Hind tarsal II accessory setae	3.6	(1-5)	4.5	(3-6)	3.7	(3-4)
Trochanter-femoral suture (length)	0.045	(0.034-0.063)	0.041	(0.034-0.051)	0.038	(0.036-0.041)
Longest seta on trochanter (length)	0.048	(0.035-0.062)	0.044	(0.033-0.050)	0.047	(0.042-0.053)

Table 2. Continued

	Apterous Vivipara n = 79		Alate vivipara n = 11		Apterous Male n = 3	
	Mean	(Range)	Mean	(Range)	Mean	(Range)
Abdomen						
Siphunculus (length)	0.42	(0.24–0.58)	0.39	(0.23–0.58)	0.21	(0.17–0.24)
Siphunculus (width at base)	0.118	(0.069–0.185)	0.092	(0.070–0.125)	0.047	(0.036–0.053)
Siphuncular setae	0		0		0	
Cauda (length)	0.14	(0.11–0.18)	0.14	(0.11–0.16)	0.09	(0.09–0.09)
Cauda (width at base)	0.13	(0.09–0.17)	0.13	(0.11–0.18)	0.11	(0.11–0.11)
Caudal setae	8.0	(1–16)	7.8	(5–10)	5.0	(5–5)
Marginal tubercle I (diameter)	0.029	(0.020–0.040)	0.032	(0.027–0.037)	0.023	(0.022–0.024)
Marginal tubercle VII (diameter)	0.023	(0.014–0.036)	0.027	(0.022–0.032)	0.017	(0.015–0.019)
Comparisons						
Head/antennal III (width/length)	1.3	(1.0–1.8)	1.1	(1.0–1.3)	1.2	(1.1–1.3)
Antenna/body (length)	0.72	(0.42–0.88)	0.70	(0.67–0.82)	0.87	(0.82–0.90)
Antenna III (length/width at base)	11.8	(8.7–15.4)	14.2	(12.4–15.9)	13.7	(11.4–16.7)
Length of longest seta on antennal III/basal width of antennal III	1.34	(1.04–1.97)	1.32	(1.02–1.55)	1.05	(1.02–1.08)
Antenna VI base (length/width at base)	7.9	(5.5–9.4)	9.3	(8.5–10.4)	8.8	(8.4–9.3)
Processus terminalis/antennal VI base (length)	2.0	(1.5–2.2)	1.9	(1.7–2.1)	2.0	(1.9–2.0)
Length of longest seta on vertex/basal width of antennal III	1.78	(1.34–2.26)	1.65	(1.29–1.92)	—	
Ultimate rostral segment (length/width at base)	2.1	(1.5–2.6)	2.3	(2.0–2.6)	2.2	(2.1–2.4)
Ultimate rostral segment/hind tarsus II (length)	0.9	(0.8–1.1)	0.9	(0.8–1.0)	1.0	(0.9–1.1)
Hind tarsus II (length/width at median)	5.6	(4.7–6.5)	6.3	(5.7–7.0)	4.8	(3.9–5.8)
Siphunculus (length/width at base)	3.6	(2.7–5.1)	4.2	(3.0–4.8)	4.5	(4.3–10.0)
Siphunculus/body (length)	0.25	(0.11–0.35)	0.20	(0.14–0.24)	0.15	(0.14–0.17)
Siphunculus/cauda (length)	3.0	(2.1–4.2)	2.8	(2.3–3.7)	2.7	(2.7–2.7)
Cauda (length/width at base)	1.1	(0.8–1.7)	1.1	(0.9–1.2)	0.8	(0.8–0.8)
Cauda/body (length)	0.08	(0.05–0.10)	0.07	(0.06–0.08)	0.06	(0.06–0.06)



Figs. 5-12. *Aphis boydstoni*. 5-10, Apterous vivipara. 5, Median and frontal tubercles (dorsal view). 6, Antennal segments iii-vi. 7, Cauda. 8, Hind tarsus and tibial apex. 9, Siphunculus. 10, Ultimate rostral segment. 11, Alate vivipara, antennal segments iii-vi. 12, Ovipara, hind tibia. Bar scale: Figs. 5, 6, 9, 11, 12 = 0.2 mm; Figs. 7, 8, 10 = 0.1 mm.

collected in open Douglas fir and ponderosa pine forests in the Cascade Mountains of Washington and southern British Columbia, and the Blue Mountains of Oregon. Further exploration may show it to exist elsewhere in the range of *Ceanothus velutinus* [British Columbia to California, east to Colorado

and South Dakota (Hitchcock and Cronquist 1973)].

Aphis ceanothi is widely scattered across western North America from British Columbia to California, and eastward to Colorado, Nebraska, and Manitoba (Palmer 1952, Smith and Parron 1978, Maw et al.

Table 3. Primary parasitoids (Hymenoptera) found attacking *Aphis boydstoni* and *Aphis ceanothi* in north-western North America.

Aphid	Collections			Primary Parasitoids No. Reared (% of total rearings per aphid species)					
	Total	Parasitized		Aphelinidae	Aphidiinae ¹				
		No.	%	<i>Aphelinus</i>	Ap	Bc	Dr	Lt	Pr
<i>A. boydstoni</i> (ex <i>Ceanothus velutinus</i>)	11	8	72.7	5 (18.5)	0	0	0	22 (81.5)	0
<i>A. ceanothi</i> (ex <i>Ceanothus</i> spp. ²)	58	47	81.0	36 (2.5)	1 (0.1)	40 (2.8)	1 (0.1)	1412 (94.4)	1 (0.1)

¹ Ap, *Aphidius polygonaphis* (Fitch); Bc, *Binodoxys carolinensis* (Smith); Dr, *Diaeretiellia rapae* (McIntosh); Lt, *Lysiphlebus testaceipes*; Pr, *Praon* sp.
² Aphid taken from *C. cuneatus* (1 collection), *C. integerrimus* (2), *C. sanguineus* (8), and *C. velutinus* (47).

2000, Pike et al. 2003). In addition to feeding on *Ceanothus velutinus*, it was found on *C. cuneatus* Nuttal, *C. integerrimus* Hooker and Arnott, and *C. sanguineus* Pursh.

Intermixed colonies.—Colonies of *Aphis boydstoni* and *A. ceanothi* were infrequently found intermixed. Of 65 aphid collections taken from *Ceanothus velutinus*, only five showed intermixed colonies, and even with these, *A. boydstoni* tended to be on the stems, while *A. ceanothi* tended to be on the leaves.

Relationship to other aphids.—Based on preliminary DNA microsatellite flanking sequence data, the two *Ceanothus*-feeding aphids are closely related to each other and belong to a group of *Aphis* that includes *A. helianthi* Monell, *A. neogillettei* Palmer, *A. nigratibialis* Robinson, and *A. viburniphila* Patch (unpublished data of Footitt and Maw).

Parasitoids.—Tables 3 and 4 summarizes the primary and secondary parasitoids found associated with *Aphis boydstoni* and *A. ceanothi*. Between 73 and 81% of the collections were parasitized, with *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Braconidae: Aphidiinae) being the predominant parasitoid present; it comprised ≈80% of the primary parasitoids associated with *A. boydstoni*, and ≈95% of the primaries associated with *A. ceanothi*. Both species of

aphids were also attacked by *Aphelinus* sp. Additionally, *A. ceanothi* was attacked by several other species of aphidiines (see Table 3). The secondary parasitoids associated with these *Ceanothus* aphids were comprised of a mix of species spanning several families of Hymenoptera (Table 4).

Lysiphlebus testaceipes is a rather broadly oligophagous parasitoid, especially common in its attack of *Aphis* spp. in the Pacific Northwest (Pike et al. 2000), and thus, its high parasitism of *Aphis boydstoni* and *A. ceanothi* is in accord with its typical preference. *Lysiphlebus testaceipes* is an important natural biological control agent of some of the crop-attacking aphid pests in the region, e.g. *Aphis craccivora* Koch on alfalfa; *Diuraphis noxia* (Kurdjumov), *Rhopalosiphum padi* (L.), *R. maidis* (Fitch), and *Sitobion avenae* (F.) on small grains. Although the aphids of *Ceanothus* are usually some distance from the region's crops, the aphids are nevertheless part of the overall biodiversity that sustain the parasitoid. And although untested, the aphid-supporting *Ceanothus*, if used in landscape plantings, might prove useful in enhancing the presence and action levels of *L. testaceipes* in nearby crops.

ACKNOWLEDGMENTS

We express thanks to D. Graf, J. Hileman, and T. Miller (Washington State Uni-

Table 4. Secondary parasitoids (through primary parasitoids) associated with *Aphis boydstoni* and *Aphis ceanothii* in northwestern North America.

Aphid	n ¹	Secondary Parasitoids No. Reared (% of total rearings per aphid species)						
		Charipidae: Alloxystinae			Encyrtidae		Pteromalidae	
		Alloxysta	Lytoxysta		Phaenoglyphis	Encyrtidae	Asaphes	Pachyneuron
<i>A. boydstoni</i> (ex <i>Ceanothus velutinus</i>)	5	0	2	(9.1)	2	1	0	17
					(9.1)	(4.5)		(77.3)
<i>A. ceanothii</i> (ex <i>Ceanothus</i> spp. ²)	29	55	203	(36.2)	26	39	5	226
		(9.8)			(4.6)	(7.0)	(0.9)	(40.4)
								6
								(1.1)

¹ No. of collections with secondary parasitoids.
² See Table 3, footnote 2.

versity technical staff), L. Boydston (former Washington State University technician), and L. Pike for assistance in collecting, mounting, photography, or parasitoid rearings; G. A. P. Gibson (Agriculture and Agri-Food Canada, Ottawa) for assistance in secondary parasitoid identification; and the Yakama Nation for allowing access to their lands.

LITERATURE CITED

Clarke, W. T. 1903. A list of California Aphididae. Canadian Entomologist 35: 247–254.

Footitt, G. G. and H. E. L. Maw. Website. [http: www.zoology.ubc.ca/~mawe/bcaphid](http://www.zoology.ubc.ca/~mawe/bcaphid).

Gillette, C. P. and M. A. Palmer. 1932. The Aphidae of Colorado, Part II. Annals of the Entomological Society of America 25: 369–496.

Gimingham, C. T. and D. Hille Ris Lambers. 1949. A new British species of *Aphis* L. from *Rhamnus catharticus* (Homoptera, Aphididae). Proceedings of the Royal Entomological Society London (B) 18: 116–118.

Hille Ris Lambers, D. 1950. On mounting aphids and other soft-skinned insects. Entomologische Berichten 13: 55–58.

Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle and London, 730 pp.

Maw, H. E. L., R. G. Footitt, K. G. A. Hamilton, and G. G. E. Scudder. 2000. Checklist of the Hemiptera of Canada and Alaska. NRC Research Press, Ottawa, Ontario, Canada, 220 pp.

Palmer, M. A. 1952. Aphids of the Rocky Mountain Region. The Thomas Say Foundation, Vol. 5, A. B. Hiershfeld Press, Denver, Colorado, 452 pp.

Pike, K., L. Boydston, and D. Allison. 1991. Winged viviparous female aphid species associated with small grains in North America: Key, morphological features and measurements. Journal of the Kansas Entomological Society 63: 559–602.

———. 2003. Aphids of western North America North of Mexico with keys to subfamilies and genera for female alatae. Washington State University Extension MISC0523, 282 pp.

Pike, K. S., P. Starý, T. Miller, G. Graf, D. Allison, L. Boydston, and R. Miller. 2000. Aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of north-west USA. Proceedings of the Entomological Society of Washington 102: 688–740.

Smith C. F. and C. S. Parron. 1978. An annotated list of Aphididae (Homoptera) of North America. North Carolina Agricultural Experiment Station Technical Bulletin 255, 424 pp.